COURSE DATA

DATA SUBJECT

Code: 34229
Name: Analytical Chemistry II
Cycle: Undergraduate Studies
ECTS Credits: 4.5
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1110 - Degree in Chemistry	Facultat de Química	2	Second quarter
1929 - Double Degree Program in Physics and Chemistry	Facultat de Física	2	Second quarter
1934 - Double Degree Program in Chemistry-Chemical Engineering	Facultat de Química	3	Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1110 - Degree in Chemistry	Analytical Chemistry	COMPULSORY
1929 - Double Degree Program in Physics and Chemistry	Segundo Curso (Obligatorio)	COMPULSORY
1934 - Double Degree Program in Chemistry-Chemical Engineering	Tercer curso	COMPULSORY

COORDINATION

CERVERA SANZ MARIA LUISA

SUMMARY

Analytical Chemistry I dealt with the basics of Analytical Chemistry and classical qualitative and quantitative analysis. Analytical Chemistry II further develops basic training in Analytical Chemistry centred on instrumental analysis.

The development of analytical methods based on instrumental techniques has enabled Analytical Chemistry to meet the increasing needs of society and technological development. Today these methods are needed to tackle most analytical problems.

The course begins with the basic concepts of instrumental analysis and the classification of instrumental analysis techniques, especially optical spectral and electroanalytical techniques.

It continues with calibration in instrumental analysis (univariate), including linear regression, straight line adjustment, and analytical parameters related to calibration. As well as conventional calibration, other calibration methods that are useful in certain cases are discussed.

The rest of the course involves the study of optical spectral and electroanalytical techniques including techniques based on molecular absorption spectroscopy in the UV/V and IR zones, analytical luminescent techniques based on molecular emission spectroscopy, analytical techniques based on flame and non-flame atomic spectroscopy, and potentiometric and voltametric techniques.

The knowledge they need regarding the foundations, instruments, experimental methods and applications of optical spectral and electrochemical analysis techniques in order to select the best ones for solving a specific analytical problem.

The knowledge and skills students acquire on this course will be reinforced in Laboratory of Analytical Chemistry II, where students will practice some of the analytical techniques studied.

The general aims of Analytical Chemistry II are to provide students with:

- an overview of the various types of instrumental analytical techniques before analysing in greater detail those that will be studied on this course.
- a solid foundation in the use of calibration methods in analytical chemistry to enable them to select the most suitable one for a given analytical problem and correctly treat the analytical results.
- the knowledge they need regarding the foundations, instruments, experimental methods and applications of optical spectral analysis techniques in order to select the best ones for solving a specific analytical problem.
- the skills they need to perform calculations in analytical problems in which instrumental analysis techniques are used.

Regarding the Sustainable Development Goals (SDGs), it is expected that students will be able to know in this subject how to apply the knowledge learned to guarantee an inclusive, equitable, and quality education and promote learning opportunities for everyone (SDG 4), to acquire a special sensitivity for sustainable management of water (SDG 6), raw materials and energy sources (SDG 7), as well as for an environmentally friendly and sustainable development (SDGs 11 , 12, 13, 14 and 15), in addition to being able to design, select and/or develop efficient chemical products, processes and/or analytical methodologies (SDG 7) that minimize their impact on the environment (SDGs 14 and 15), using alternative raw materials and reducing wastes (SDG 11).

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

OTHER REQUIREMENTS

To successfully complete this course, students should have acquired knowledge from previous courses, especially from Analytical Chemistry I, which they completed in their first term.
Specifically, students will need basic knowledge of the analytical process and the chemistry of solutions.

COMPETENCES / LEARNING OUTCOMES

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Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.

Act autonomously in learning, making well-founded decisions in various contexts, forming judgements based on experimentation and analysis, and applying knowledge to new situations.

Address new problems and propose strategies to solve them.

Apply metrology in chemical processes, including quality management.

Carry out standard experimental procedures involved in synthetic and analytical work, in relation to organic and inorganic systems.

Collaborate effectively in work teams, assume responsibilities and leadership roles, and contribute to collective improvement and development.

Communicate effectively both orally and in writing, adapting to the context and audience.

Contribute to the design, development and implementation of solutions that respond to social demands, using the Sustainable Development Goals as a reference.

Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate.

Demonstrate ability to work in teams both in interdisciplinary teams and in an international context.

Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional.

Demonstrate both inductive and deductive reasoning skills.

Demonstrate critical and self-critical thinking, considering professional ethics, moral values and social implications of the different activities carried out throughout the degree.

Demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the areas of chemistry.

Demonstrate knowledge of the main aspects of chemical terminology, nomenclature, conventions and units.

Demonstrate knowledge of the main types of chemical reaction and their main characteristics.

Demonstrate knowledge of the principles, procedures and techniques for the determination, separation,

identification and characterisation of chemical compounds.

Demonstrate knowledge of the principles of thermodynamics and kinetics and their applications in chemistry.

Demonstrate the ability to adapt to new situations.

Demonstrate the ability to analyse, synthesise and reason critically.

Develop sustainable and environmentally friendly methods.

Distinguish between the qualitative and quantitative aspects of chemical problems.

Distinguish the principles, procedures and techniques used in the determination, separation, identification and characterisation of chemical compounds.

Evaluate, interpret and synthesise chemical data and information.

Evaluate the risks in the use of chemicals and laboratory procedures.

Evaluate the risks involved in the use of chemical substances and laboratory procedures.

Express ideas correctly, both orally and in writing, in any of the official languages of the Valencian Community.

Express oneself correctly, both orally and in writing, in any of the official languages of the Valencian Community.

Handle chemicals safely.

Handle the instrumentation used in the different areas of chemistry.

Have basic skills in the use of information and communication technology and properly manage the information obtained.

Identify chemical processes in everyday life.

Identify the main types of chemical reactions and their associated key characteristics.

Implement sustainable and environmentally friendly methodologies.

Interpret data from observations and measurements in the laboratory in terms of their significance and the theories that underpin them.

Interpret the relationship between the variation in the characteristic properties of chemical elements and the Periodic Table.

Interpret the variation of the characteristic properties of chemical elements according to the periodic table.

Learn autonomously.

Propose creative and innovative solutions to complex situations or problems in the field, addressing

diverse professional and social needs.

Recognise and analyse new problems and plan strategies to solve them.

Recognise and evaluate chemical processes in daily life.

Relate chemistry to other disciplines.

Relate chemistry with other disciplines.

Relate theory and experimentation.

Relate theory to experimentation.

Show knowledge of the metrology of chemical processes including quality management.

Solve problems effectively.

Solve problems effectively.

Solve qualitative and quantitative problems following previously developed models.

State the principles of thermodynamics and kinetics and their application in chemistry.

Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.

Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.

Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.

Understand and analyse, from the perspective of the degree programme, social inequalities based on sex and gender; integrate gender-sensitive approaches into problem-solving and solution design.

Understand the qualitative and quantitative aspects of chemical problems.

Use chemical terminology, nomenclature, conventions and units correctly.

DESCRIPTION OF CONTENTS

1. Introduction to Instrumental Analysis Techniques

Conceptual evolution of instrumental analysis. Classification of instrumental analysis techniques. Spectroscopic analysis techniques. Criteria for choosing the instrumental technique. Design and basic components of the instruments used in analytical spectroscopy.

2. Calibration

The concept of calibration and its importance in instrumental analysis. Conventional or external calibration. Linear regression. Simple and weighted least squares. Analytical parameters related to the calibration. Sensitivity, limits of detection, limits of quantification. Using a calibration curve to determine the concentration of an analyte in a sample. Calibration using an internal standard. Detecting and correcting matrix effects using standard addition calibration.

3. Introduction to electroanalytical methods. Potentiometry.

Electrochemical cells. Cell potential and electrode potential. Electrode reactions. Polarization. Classification of electroanalytical methods. Potentiometric methods: reference electrodes and indicator electrodes. Selective electrodes. Direct potentiometry: instruments and calibration. Potentiometric titrations.

4. Voltammetry

Working electrodes. Instrumentation. Classification of voltammetric methods. Polarography. Pulse voltammetry. Stripping voltammetry. Amperometric titrations.

5. Introduction to Spectroscopic Analysis echniques. UV/V Molecular Absorption

Introducció a les tècniques espectroscòpiques d'anàlisi. Espectroscòpia d'absorció molecular en la zona ultraviolada/visible (UV/V). Espectres atòmics i moleculars: la seua utilització en anàlisi instrumental. Fonaments de l'espectroscòpia d'absorció molecular en l'UV/V. Llei de Beer i condicions d'aplicació. Factors que influeixen sobre l'absorció molecular en l'UV/V. Ús analític de l'espectrofotometria UV/V. Instrumentació i variables d'interès. Metodologia experimental. Interferències i mètodes per a la seua correcció. Resolució de mescles: sistemes d'equacions lineals. Ús d'espectres derivats. Aplicacions analítiques de major interès en l'actualitat.

6. Molecular Emission Spectroscopy

Fundamentals of molecular emission spectroscopy. Excitation and emission spectra. Fluorescence and phosphorescence. Factors that influence fluorescence, phosphorescence and interferences. Analytical use of molecular luminescence. Instrumentation and variables of interest. Experimental methodology. Other

techniques: analytical use of chemiluminiscence. Analytical applications. Comparing the techniques of absorption and emission molecular spectroscopy.

7. Atomic Spectroscopy I

Fundamentals of atomic spectroscopy. The atomization process. Analytical use of atomic spectroscopy. Techniques based on flame atomization: atomic absorption and emission. Instrumentation and variables of interest. Experimental methodology. Types of interference and methods of correction.

8. Atomic Spectroscopy II

Electrothermal atomization techniques: instrumentation and variables of interest, experimental methodology, interference and correction. Atomic absorption techniques using cold vapour hydride generation: instrumentation and variables of interest, experimental methodology; interference and correction. Atomic fluorescence. Atomic emission using inductively coupled plasma atomization. Instrumentation and variables of interest, experimental methodology, interference and correction. Comparison of the atomic techniques. Analytical applications of the atomic techniques.

9. Infrared Molecular Absorption Spectroscopy

Fundamentals of molecular absorption spectroscopy in the infrared (IR) zone. Analytical use of infrared spectroscopy. Instrumentation and variables of interest. Experimental methodology. Sampling techniques and sample manipulation techniques. Fourier Transform Infrared Spectroscopy. Attenuated total reflectance. Diffuse reflectance. Analytical applications of major interest today.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Tutorials	7,00
Theory	38,00
Total hours	**45,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	0,00
Independent study and work	42,00
Preparation of lessons	0,00
Preparation for assessment activities	25,50
Resolution of case studies	0,00

Total hours	**67,50**

TEACHING METHODOLOGY

This course will consist of classroom lectures for the theoretical concepts, problem-based learning sessions, group tutorials and/or seminars.

The lectures will present an overview of the topics contained on the course.

The problem-based learning sessions will provide the basis for solving problems or issues related to the theoretical contents.

The tutorials will be used to solve the theory-related problems or issues.

The seminars will be used to solve practical cases related to the instrumental analytical techniques discussed in the lectures.

To grade the students' work, the professor may evaluate:

- assignments they have completed inside or outside the classroom

- classroom participation, including the standard of work presented, responses to questions asked, presentations, etc.

EVALUATION

FIRST CALL

The assessment of student learning will consider all the aspects outlined in the methodology section of this teaching guide. The evaluation consists of two components:

1) Tests (70%): These tests include written, oral, and/or practical exams.

2) Continuous Evaluation (30%): Each student's performance is assessed based on the proposed activities (questions, exercises, evaluation tests, etc) participation, and engagement in the teaching-learning process. Note that continuous evaluation activities are non-recoverable.

The final mark will be the sum of the exam mark and the marks obtained in all assigned activities, according to the previously indicated percentages. To pass the course, the student must obtain a minimum mark of 4.5 on the final exam, and the weighted average must be equal to or higher than 5. There is no minimum mark required in continuous evaluation to average with the exam, but the mark obtained in this part will necessarily be included in the calculation of the final course mark.

Copying or plagiarism of any assignment that is part of the evaluation will result in the impossibility of passing the course, and the student will be subject to the appropriate disciplinary procedures.

It should be noted that, according to Article 13 d) of the University Student Statute (RD 1791/2010, December 30), "it is the duty of a student to refrain from using or cooperating in fraudulent procedures in evaluation tests, in the work performed or in official documents of the University".Evaluation system of the subject.

SECOND CALL

In the second call, the mark will be obtained by applying the same criteria as in the first call.

REFERENCES

BASIC

- SKOOG, D.A.; WEST, D.M.; HOLLER, F.J. Y CROUCH, S.R. Fundamentos de Química Analítica, 8ª edición. Madrid: Thomson-Paraninfo, 2005.ISBN: 9788497323338
- SKOOG, D.A.; HOLLER, F.J. Y NIEMAN, T.A. Principios de Análisis Instrumental, 5ª Edición. Madrid: McGraw-Hill, 2001. ISBN 8448127757
- HARRIS, D.C. Análisis Químico Cuantitativo, 3ª Edición. Barcelona: Reverté, 2007. ISBN 9788429172249
- HARVEY, D. Química Analítica moderna. Madrid: McGraw-Hill, 2002.ISBN 9788448136352
- HERNÁNDEZ, L. Y GONZÁLEZ-PÉREZ, C. Introducción al Análisis Instrumental. Barcelona: Ariel Ciencia, 2002. ISBN 8434480433
- MILLER, J.N. Y MILLER, J.C. Estadística y Quimiometría para Química Analítica. Madrid: Prentice Hall, Pearson Educación, 2002. ISBN 8420535141
- RÍOS CASTRO, A.; MORENO, M.C. Y SIMONET SUAU, B. M. (coords.) Técnicas espectroscópicas en Química Analítica, 2 vols. Madrid: Biblioteca de Químicas. Síntesis. Madrid, 2012. ISBN 9788499589312
- "Análisis instrumental". Raquel Bermejo Moreno y Antonio Moreno Ramírez. Editorial Síntesis, 2014.

ADDITIONAL

- ¿Química Electroanalítica¿. José Manuel Pingarrón Carrazón y Manuel Sánchez Batanero. Editorial Síntesis, 2003.